

Aging Culverts Problems and Repairs



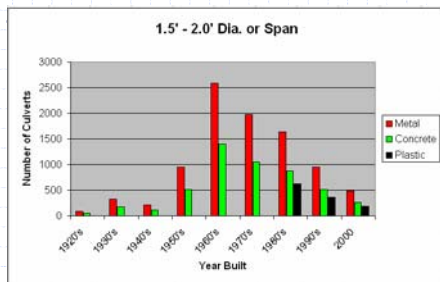
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How many Culverts are out there?

- ~ 60,000 Culverts on the State System
- Replacement Cost ~ \$ 400 Million
- No formal rehabilitation program in place
- Traditionally Maintenance is "as-needed"

Culverts by Decade Installed ~ 72 % are CMP's

- Note- problems begin showing up at 35+

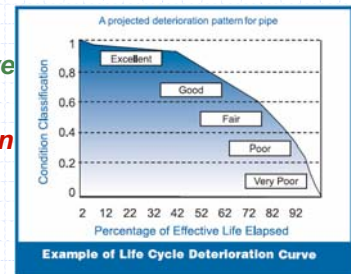


Culvert Deterioration Patterns

- Culverts deteriorate with time

Actions:

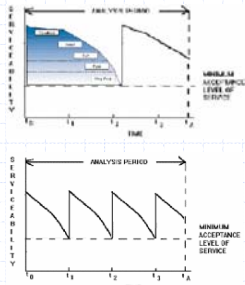
- Preventative
- Corrective
- Replacement



Preventative Maintenance:

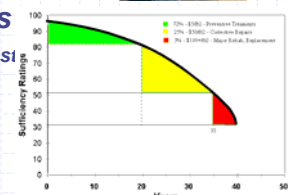
Any Actions that slow aging !

- Get rid of Standing water
- Clean Debris from Barrels
- Repair Joints
- Install Invert Treatments
- Other



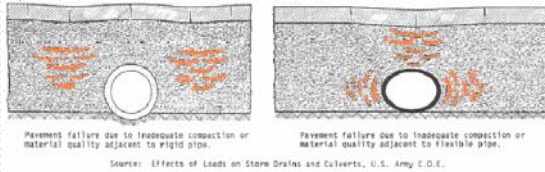
Prioritize:

- \$ Costs
- (Diameter & Depth of Bury)
- Traffic Impacts
- Interstates 1st



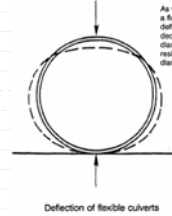
Migration of Soil Fines

- migration looks just like poor compaction ...

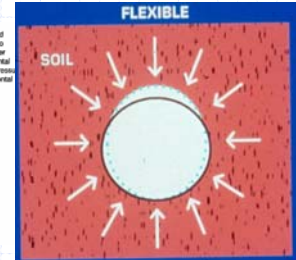


Structural Behavior of Flexible Pipe

- Flexible pipe has no real strength on its own



As vertical loads are applied a flexible culvert attempts to deflect. The vertical diameter decreases while the horizontal diameter increases. Soil mass resist the increase in horizontal diameter.



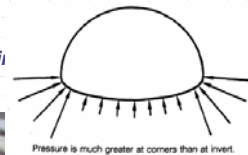
... So look for Dips

- Migration ?
- Piping ?
- Bad Compaction ?



Signs of Failure in CMP & Pipe Arches

- Gross distortion is NOT normal !
- Verify if movement is slow or accelerating



Look for Leaking Joints

- Winnowing of Fines leads to Sink Holes



Look for Bad Joints

- "Faulting"
- Excavate and Relay Section



Look for bad Inverts

- Then Look for "Piping"



Migration of Soil Fines

- In Worst Cases leads to Sink



Piping Led to > \$ 4 Million Failure on I-70



- CDOT now has a culvert inspection program

Which Condition is More Serious ?



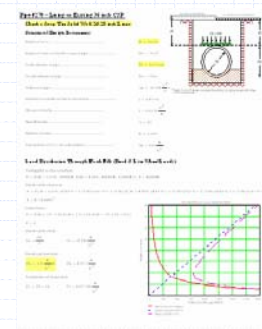
Segmental Sliplining Notes

Segmental Plastic Pipe Liners
Segmental Metal Pipe Liners
Segmental Thermoplastic Pipe Liners

and also
Cured in Place Pipe Liners

Remember Structural Strength !

- Select based upon fill height.
- When durability thickness is higher than structural thickness, provide the 1-inch corrugation profile for diameters over 48 inches.
- Show the gage thickness in the plans if it is above the minimum shown in the Standard Drawing !



Sliplining

- Step 1
- Flush and/or clean the existing culvert.



Sliplining

- Step 2
- Insert Liner into existing culvert.



Sliplining

- Step 3
- Next section watching out for alignment.



Sliplining

- Step 4
- Align the Ends & Screw or Snap Liner together



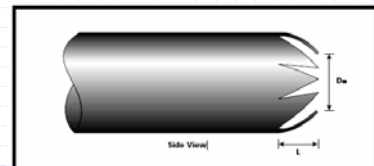
Sliplining

- Step 5
- Push liner into culvert & repeat as needed



Sliplining – Alternate Pulling Strategy

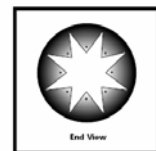
- Where access is available at both ends of the culvert



Side View
L = about 12" to 16"
D_{WT} = about 3/4 Dia. of pipe

Example: 24" pipe, D_{WT} = 18"
36" pipe, D_{WT} = 27"
42" pipe, D_{WT} = 32"

End View
Make 8 Dove Tails
Drill hole 1/2" ± about 1" from point of Dove Tail.
Draw pieces toward each other by connecting wire to opposite holes and twisting the wire to



– Alternate Pulling Strategy



Sliplining

- Step 6
- Seal with grout
- Fill the piping voids
- Provide uniform support



Grouting Alternatives



Sliplining Alts.



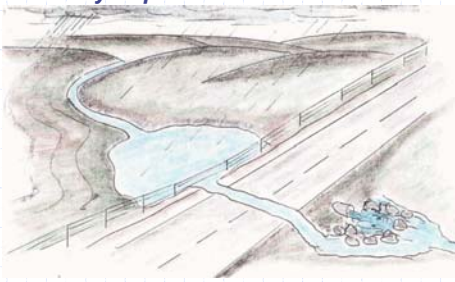
- The exterior of Aluminized Type 2 steel pipe should be painted with zinc phosphate.
- All welds are to be painted with a zinc rich paint

- Flowable Fill fills annular space easily
- Damaged Polymer Coating should be repaired with appropriate coating



Remember the purpose of culverts is to pass drainage flows under highway pavements.

- rehab has hydraulic as well as structural and durability requirements.



Sliplining

- Step 7 - Create Desirable End Detail



Sliplining CMP Arches

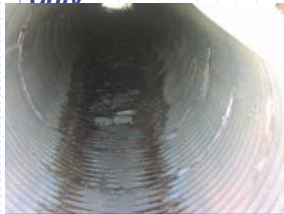
- Arches require special bracing to maintain line & grade
- Grouting should be done in a minimum of 3 lifts with a 1 day cure between grouting



Invert Repair Notes

Typical Abrasive Conditions:

- Note loss of zinc coating in invert only



Typical Non-Abrasive Conditions

- Lacks Coarse Materials



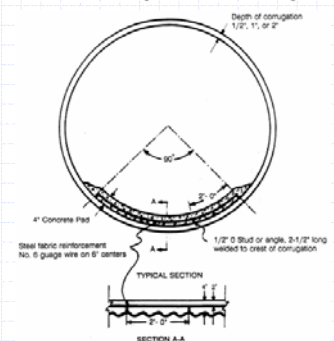
Abrasive Conditions ? ... Pave the Invert

- Studs & shotcrete/concrete will protect an



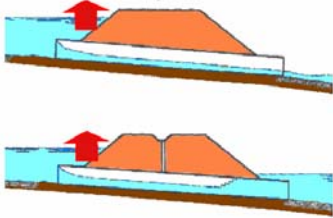
Paving the Invert (continued)

- Contact the Structures Division for mix designs & finishing requirements



Buoyancy Risks:

- **Ponded Inlets are subject to buoyant**



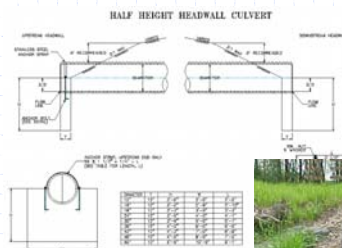
Inlet Control = Buoyancy Uplift Hazard = Property Loss + Life Safety Hazards

Buoyant (uplift) failures

- **Prevention of buoyant failures requires**



Example of Plastic Anchorage Requirements:



Don't wait too long or you will no alternative but to dig it up !



Trench Safety Considerations

- **Dangerous !**
- **5 People Die in Trenches EVERY Week!**
- **Use All Recommended Safety Equipment**
- **Use Trench Boxes in Compliance with OSHA Regulations**



The End

Dr. Joseph Perrin's Costs of Failed Culverts

Location	I-78 east of Vail, Colorado	I-480 near Maple Heights, Ohio	SR-79 near Buckeye Lake, Ohio	SR-173 Taylorsville, Utah	I-70 Eisenhower Tunnel, Colorado	I-75 near Prudenville, Michigan	Highway 401 near Milton, Ontario Canada
Pipe Size / Type	66" CMP	60" CMP	30" CMP	81" X 59" Arch CMP	60" CMP	72"x55" Arch CMP	30" (750mm) CMP
Costs of Replacement	\$4,200,000	\$384,000	NA	\$48,000	\$45,000	\$98,000	NA
Length	85-100'	NA	50'	50'	40'	50'	40'
Time to Replace (Days)	49	8	6	5	7	6	1
Impacted AADT	20,950	16,760	4,320	19,338	1,257	5,102	45,000
Detour Delay	120 min	60 min	20 min	20 min	30 min	20 min	240 min
User Cost	\$4,046,000	\$3,079,000	\$290,000	\$880,000	\$220,000	\$249,000	\$5,033,000
Total Costs	\$8,246,000	\$3,463,000	NA	\$741,000	\$265,000	\$344,000	NA
Pipe Age (yrs)	35-60	60	30+	20	30	30	25
Number of Replacements (Compared to 100 year design life)	1	1	3	4	2	2	3
Total Costs for 100 yr Horizon	\$8,046,000	\$3,463,000	NA	\$2,954,000	\$530,000	\$668,000	NA
Estimated Cost to change to 100 year pipe	\$12,000	\$13,000	NA	\$6,200	\$4,500	\$6,200	NA
Cost-Benefit Ratio	071	260	NA	478	118	111	NA

CULVERT INSPECT COST VS. EMBANKMENT REPAIR COST

